40 Corrections

Dec. 18, 1997

Information for the NASA Ames Aeronautical Test & Simulation Community

SOFIA Test in 14-Ft. TWT

Answering Questions on Airborne Astronomy

by Sharon Marcacci

The Stratospheric Observatory for Infrared Astronomy (SOFIA) will replace NASA's Kuiper Airborne Observatory (KAO) which was retired in 1995. SOFIA will begin science flights in 2001. The increase from a 91 cm KAO telescope to the 2.5 meter SOFIA telescope requires a larger aircraft with a much larger opening. The aerodynamics of the large open telescope cavity and door present unique challenges. Last month the 14-Ft. Transonic Wind Tunnel (TWT) was used for conducting tests to investigate the telescope cavity and door configurations, as well as telescope torque loads. The SOFIA V test was the fifth in the ongoing project in the 14-Ft. TWT. Early tests looked at general characteristics of flying in the upper atmosphere with an open port. Later tests evaluated two funda

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History of the SOFIA Project:

A Peek into the Universe

NASA's Stratospheric Observatory for Infrared Astronomy (SOFIA) will observe a universe hidden from astronomers by Earth's atmosphere. In the clear, dry environment on the very edge of space, between 41,000 and 45,000 feet above Earth, SOFIA's powerful telescope will allow scientists to view objects in the infrared region of the electromagnetic spectrum.

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Inside....

747 Decision Making Study

Analysis of Flight Crew Caused Accidents

by Barry Sullivan

CVSRF (Crew Vehicle Systems Research Facility) staff recently completed experiment runs on the 747-400 Simulator in support of the Decision Making Study. This study was conducted by the Aviation Safety Research Branch in the Flight Management & Human Factors Division. The study was designed to determine factors that influence pilots' success in monitoring and detecting problems that arise in flight, or errors committed by the other pilot, as well as communication strategies used to call attention to, or correct those problems. In an analysis of flight crew caused accidents conducted in 1994, the National Transportation Safety Board (NTSB) found that 31 out of 37 accidents involved failures of "monitoring and challenging." That is, one crew member made an error, or a problem developed, which was noted by another crew member who then failed to call attention to the problem or correct it, resulting in an unsafe situation.

In most of these cases, it was the first officer who was unable to get the attention of the

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ACFS Upgrade Completed

A new flight deck was constructed including instrument panel and center console, elaborate auto-throttle system, new flight displays, new aural cueing system, and a new Flight Dynamics Inc. Head Up Display.

by Matthew Blake

A multi-year effort to upgrade the Advanced Concepts Flight Simulator (ACFS) was recently completed with the successful approval by the Human Occupancy Review Board (HORB) to return the ACFS to service on August 25, 1997. This concluded the successful upgrade of nearly all computational and electronic systems and a completely new flight deck and simulator enclosure.

The ACFS Upgrade Project was started in 1995 following the recommendations of an Integrated Product Team (IPT). The IPT was formed to determine what air transport simulation capabilities were needed to support NASA mission critical research in the areas of aeronautical human factors, aviation safety, and airspace capacity. The IPT included personnel from NASA simulation and research organizations as well as the Federal Aviation Administration (FAA). The conclusion was that the ACFS was needed and a list of specific improvements was generated. Over the intervening 2 years, all major IPT recommendations were completed.

The ACFS Upgrade Project included a comprehensive upgrade of nearly all simulator systems in order to achieve much higher fidelity and provide systems that are flexible, reliable, and inexpensive to maintain. All simulator computational systems were replaced including the host computer, flight display computers, Experimenter Operator Station (EOS) computers, digital data communication system, and real-time data conversion (Input/Output (I/O)) and communication systems. A new flight deck was constructed including instrument panel and center console, elaborate auto-throttle system, new flight displays, new aural cueing system, and a new Flight Dynamics Inc. (FDI) Head Up Display (HUD). The simulator structure was stripped down to essentially the base platform and a new Flight Safety International (FSI) MultiView projection visual system was installed, including construction of an entirely new cockpit enclosure and support structure. The new projection system provides 180 degree horizontal field of view (FOV) and 40 degree vertical FOV, presenting both raster and calligraphic images. The new image generator is a FSI Vital 8i, which presents daylight, dawn, dusk, and night scenes with many special effects and includes databases representing numerous airport areas throughout the world.

An additional software development effort to significantly enhance the Flight Management System (FMS) was performed in parallel with the ACFS Upgrade Project. This effort includes a

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Management Changes at Ames

In early November, the following memo was sent to AO staff from Fred Schmitz, Director of Aeronautics at NASA Ames, regarding AO management changes:

"Over the past four months, management has conducted an assessment of large-scale wind tunnel and simulation efforts at Ames. As a result of these studies, it has been decided that a new organizational structure is needed to re-focus our efforts towards our major product lines of world class wind tunnels and simulators. To this end, a wind tunnel management structure for a new wind tunnel division is being developed. A study is also underway to determine the best operational structure for large-scale simulation at Ames. It is anticipated that these planning studies will be completed in early December enabling Ames to define the final management configurations for Wind Tunnel and Simulation efforts. In the interim period, the current organization will remain in place.

"Mr. Dave Jones will manage Simulation activities from his current position as Associate Chief for Simulation. His office will be in Building N-243, Room 100, M/S 243-1. His phone number remains unchanged at 4-5928. Effective November 3, 1997, Mr. Mike George will be detailed from Code ADD to act in the capacity of Chief of AO. He will manage Wind Tunnel activities. His new mail stop and phone number are M/S 227-4 and 4-5881 respectively. Mr. Mark Betzina has requested to return to his position as Associate Chief for Wind Tunnels effective November 3, 1997. His mail stop and phone number remain unchanged."

In late November, another memo was sent out to all Ames staff, announcing the upcoming retirement of Fred Schmitz from government service after 27 years of federal employment. Dr. Robert Rosen, Associate Director for Aerospace Programs will be serving as Acting Director of Aeronautics, overseeing the Aeronautics Directorate, with the exception of the Aeronautical Test and Simulation Division. The latter will be managed by Nancy Bingham, Associate Director for Planning.

Aero Design Team Looking For Volunteers

New Interactive Aeronautics Education Project

by Susan Lee

The NASA Quest Project and the Office of Aeronautics at Ames invite employees to participate in an interactive education project called "Aero Design Team Online." "This is an Internet-based educational outreach program that will share real life experiences about the 'behind-the-scenes' aeronautics work that goes on at Ames with students and teachers around the world," said George Kidwell from the office of Aeronautics. "The goal is to demonstrate to students the variety of skills and educational backgrounds involved in Aeronautics Design."

The Aeronautics Design Team Online project will reach classrooms via the Internet beginning in November 1997. "The project will target students in grades 4-12; however, the unique perspective of Aero Design Team Online will certainly be of interest to a much broader group," said Karen Traicoff, Manager for the Quest Project. "Aero Design Team Online will ultimately be a general outreach program."

Volunteers are needed to share their expertise with students. Each volunteer will write a brief autobiography and two or three "field journals" describing their day-to-day activities. Volunteers also will answer a limited number of email questions from students. Finally, some volunteers will be involved in Web chats. After the project ends, the question-and-answer archive will remain available indefinitely.

Aero Design Team Online belongs to a family of successful online education projects such as "Live from Mars," "Shuttle Team Online," and many others. Online examples are available at http://quest.arc.nasa.gov/interactive/. "We're very excited to bring this NASA project to schools in the U.S. and around the world," Traicoff said. "We also look forward to working with employees, the people who make it happen." To volunteer, or for more information, contact Susan Lee at x40766 or email at slee@mail.arc.nasa.gov. This month's AO Connections article contributor Estela Hernandez (see article, below) is on the 'team', and participated in an online chat with students in early December!

'Partial Authority' Helicopter Simulation

by Estela Hernandez

The 'Partial Authority' helicopter simulation in August is part of the army's Improved Cargo Helicopter (ICH) program. This simulation built upon the CH-47D "Chinook" flight test results performed by U.S. Army Airworthiness Qualification Test Directorate in 1993-5, and simulations performed in-house on the VMS (Vertical Motion Simulator) in 1995-7. It was the last opportunity to investigate and resolve issues prior to submitting initial handling qualities requirements for the ICH program.

The focus of this VMS simulation was to refine the CH-47 control laws to improve the longitudinal handling qualities for aggressive maneuvering. This simulation produced data to define control system changes for a helicopter flight test evaluation at Ft. Rucker, Alabama.

The experiment had two principal objectives. The first was

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CH-47D 'Chinook' flight test, at US Army Airworthiness Qualification Test Directorate (then located at Edwards Air Force Base; now at Ft. Rucker.)

747 Decision Making Study

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captain or induce him to change his decisions or actions. Several conditions may have existed: (a) the "observer" crew member may not have noticed the problem, (b) may have noticed the problem but may have not said anything, (c) may have noticed and may have said something, but was not successful in producing a change in course of action, or (d) may both have noticed and successfully changed the situation.

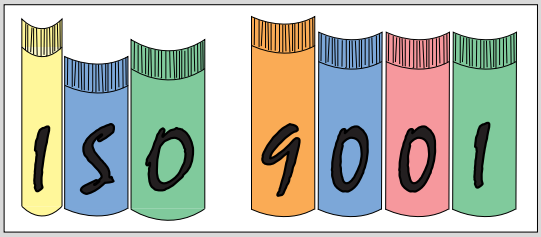
Little research has been done to date to examine the factors that determine when crew members notice problems and decide to intervene, and what intervention strategies are successful in doing so. A pencil and paper study to address the same issues, begun prior to the full-mission study in the 747, had yielded some preliminary findings. These findings included the facts that captains were found to be more direct in addressing first officers than first officers were in addressing captains, and communication was less mitigated in high risk situations than in low risk situations. The intent of the 747 simulator study was designed to complement the pencil/paper study by determining how pilots actually respond while flying, in contrast to what they say they would do.

Flight scenarios developed for this study differed in the degree to which the pilot flying was responsible for the problem or error, and by the level of risk posed by the problem or error. Problems for which the pilot flying were not responsible were mainly caused by either air traffic control (ATC), other traffic, or weather. The pilot flying (who committed the error) was either the captain or the first officer, which meant that the verbal challenge had to be directed to a crew member of either higher or lower status within the flight deck.

In order to create the "scripted" scenarios, a confederate pilot was used during each of the runs. The confederate pilot, who was a retired 747-400 airline captain, played the role of either pilot or first officer, depending on the particular run. The confederate also committed the scripted errors, as per the experimental design. Each day's runs consisted of five different line oriented flight scenarios which introduced low and high risk situations, designed to look at three factors: (1) crew position - captain versus first officer, (2) risk level - high versus low, and (3) face threat (type of problem). Verbal responses to these errors and to problems created by the air traffic controllers or the subject pilot constituted the dependent measure.

Pilot and first officer in 747-400 Simulator.

The five scenarios included flights between San Francisco and Los Angeles, Reno, and Sacramento, and Sacramento to Reno. In addition, the time for the pilot to respond after cues signaling a problem had been presented was also analyzed. Typical events which occurred included an altitude bust, a revised turn, a reroute through weather, or determining whether or not to navigate through a hole in a storm front. Experiment runs for this study went from late August until early October. Overall, 22 subjects (11 captains and 11 first officers) participated in this study. Preliminary findings suggested that overall, participating captains did not perceive that the events which took place in the study were as risky as perceived by the participating first officers when faced with the same situations.



What Do I Say To The ISO Auditor?

by Sally Brew

Internal and external audits are an important part of becoming a certified ISO Quality System. Many AO employees have already been involved in the division internal audits either as an auditee or an auditor. Following the first round of internal audits, AO employees are correcting the nonconformances in preparation for the pre-certification audit to be conducted by the registrar, Det Norske Veritas (DNV), late January, 1998.

The word "audit" for some raises real concerns, similar to those raised when audited by our friendly government auditors like the IRS. However, the intention of the division's internal audit is really to help all employees improve our quality system and to be prepared for external audits conducted by DNV. How can one prepare for an audit? First of all, auditees should be prepared to answer two basic questions of the auditor:

- What do you do?
- Show me the documented procedures that tell you what to do in your work. (Are the procedures a controlled document? How do you know that you have the latest version of the document?)

Advanced Concepts Flight Simulator (ACFS)

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team comprised of personnel from both the Aeronautical Test and Simulation Division and the Flight Management and Human Factors Division. This system is now being integrated into the ACFS.

The ACFS has now entered an operational phase where most resources are dedicated to specific research programs.

The first test, in Jan. '98, "utilizes the Taxiway Navigation And Situation Awareness (T-NASA) system."

The first experiment, scheduled to run in January, utilizes the Taxiway Navigation And Situation Awareness (T-NASA) system. This system provides the crew with a HUD guidance system and airport moving map display for improved airport taxi operations in low visibility. The second scheduled experiment will study direct electronic links of Air Traffic Control (ATC) flight plans to the aircraft FMS. This study will utilize the NASA Ames developed Center-TRACON Automation System (CTAS) and the new ACFS FMS software.

ACFS with new structural enclosure.

One concern of auditees is how much their procedures must be written down. There are several levels of documentation. The highest level is the AO Quality Manual which is on the AO Server. Next, each of the branches or facilities has written procedures such as the SOP's. More specific written procedures are work instructions, such as procedures for doing an internal audit or installing instrumentation for a test. Any employees who have questions on documented procedures which exist for their work should consult their manager.

In addition to knowing the documented procedures that govern the work they do, employees should be aware of some do's and don'ts of audits. Following are some of the key DO's and DON'T's of audits:

DO:
- Know the meaning of the division's Quality Policy
- Know where quality records are for which you are responsible
- Answer questions truthfully.
- Take time to think about answers before giving them.
- If you don't know the answer direct the auditor to your supervisor. Don't make up an answer that you are not sure about.
- Ask for clarification if you don't understand the question.
- Be as direct as possible when answering questions.
- Be sure you understand any problems that the auditor finds so you can correct the problem before future audits.
- Follow procedures and work instructions rigorously.
- Make sure your work area is neat and orderly.

DON'T
- Criticize co-workers or the division.
- Act like the auditor is wasting your time.
- Think your answers won't count.
- LEAD THE AUDITOR TO PROBLEMS. (Let the auditor find them.)
- Be afraid to answer, "I don't know, but I'll find out."
- Guess at answers or try to bluff through an answer.
- VOLUNTEER INFORMATION NOT ASKED FOR. Let the auditor lead the audit.
- Argue with the auditor.
- Say you don't follow procedures because...you don't have time...it can't be done that way...you don't need written procedures.

The internal auditors have found that the auditees in the division have so far been well prepared for the audits. Overall the division does benefit from auditing ourselves on how well we follow documented procedures which tell us how to do our business.

Jerry Guzman (EOM) Solves Database Problem

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Jerry Guzman reformatted the database and also realized that he could reformat the version 3.0A in a similar manner. Jerry's solution retains all the data that would have been lost using other approaches. This saved 1-month of full time working effort and also saved AO Division approximately $6,000, the cost of having the PSDI consultant visit Ames. Since implementing this database solution, the system has been used without encountering any glitches. Jerry's solution is now being applied to the Unitary and NFAC databases that have also encountered similar database problems.

Jerry has been chosen as a Contractor Employee of the month for pushing himself well beyond his expected performance requirements, and using a high degree of talent and innovation to develop a solution to a major and costly Maximo database problem. Jerry has also now become probably the most knowledgeable and efficient person at Ames with the Maximo CMMS.

SOFIA in the 14 Ft.

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mentally different telescope models.

The 7% model, built by Microcraft, is a simulation of a Boeing 747-SP. The model's wings were cropped at the mid-outboard pylon station in order to fit into the 14' by 14' wind tunnel. The missing sections of the wings do not affect the test data. According to George Rupp, Test Manager for the SOFIA V test, "Analysis was done to verify that flow around the outboard edges of the wing won't affect flow around the cavity."

The SOFIA V test ran during the month of November. Bill Rose, of Rose Engineering and Research, is the principal investigator for the test. According to Bill Rose, the test was a developmental one rather than a production test. "A production test goes through predetermined configurations," states Bill. "A developmental test begins with one configuration and then becomes an evolutionary process, as design changes and further testing continue to take place."

The SOFIA V test investigated alternate door designs, including a 'partial-external' door. The test data will allow engineers to select between door designs. The most recent test model, SOFIA IV, had a 'barrel door' over the telescope, which is located on the upper port side of the fuselage, downstream of the wing root. This was an internal rotating cylinder with an opening on one side. When the cylinder rotated inside the plane, the door was opened. The partial external door design is being evaluated as a possible alternative to the barrel door configuration.

SOFIA model in the 14-Ft. TWT.

Additional SOFIA V test objectives were to obtain data that will help with telescope design. The telescope cavity on the SOFIA model contains a scale mode of the most recent German designed telescope, which is instrumented to measure up to sixty unsteady pressure sites. Torques were measured during all portions of the test. The test data will demonstrate the torque loads on the telescope, generated by unsteady cavity airflow.

During the test, a range of Mach numbers, angles of attack, and telescope elevation angles were investigated. The Mach range for this test was 0.30 to 0.92. The primary cruise speed was Mach 0.85. George Rupp states, "This test is more complex than the typical SOFIA test, due to the intermediate Mach number range testing. This is a significant part of the test, as it will measure cavity properties at descent from mission altitude with the cavity door open."

Baseline testing began with a closed cavity, followed by a test with the telescope installed and an open cavity. Configuration testing followed, including at least one week of testing using the "barrel door" carriage system used in the SOFIA IV, and another week testing the newly designed and fabricated 'partial-external' door. Aperture treatments simulating the aerodynamic nature of the partial-external door were fabricated and attached to the carriage system. After the door carriage alternatives were investigated, additional test data was collected to further assist engineers in designing the optimum door configuration for the SOFIA aircraft.

According to George Rupp, the SOFIA V test objectives have been met. George states, "We were able to measure torques on the telescope, and come up with some aerodynamic treatments around the cavity to reduce torque loads on the telescope." Although still in the early stages of data analysis, initial indications look promising.

SOFIA V Test Manager George Rupp (right) and principal investigator Bill Rose check out the test model in the 14-Ft. (Arrow points to telescope cavity and scale telescope model.)

SOFIA History

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The mission of the observatory is described at the SOFIA web site (http://sofia.arc.nasa.gov). With the SOFIA telescope, scientists will investigate many phenomena, including:

- Interstellar cloud physics and star formation in our galaxy
- Proto-planetary disks and planet formation in nearby star systems
- Origin and evolution of biogenic atoms, molecules, and solids
- Composition and structure of planetary atmospheres and rings, and comets
- Star formation, dynamics, and chemical content of other galaxies
- The dynamic activity in the center of the Milky Way

In addition, teachers, students, writers and others will join research missions on SOFIA. People of all ages will be engaged in airborne astronomy.

Infrared astronomy is the basis for much of the observations made by the SOFIA and other airborne astronomical telescopes. According to E.F. Erickson and J.A. Davidson in their April 1995 journal paper, 'SOFIA: The Future of Airborne Astronomy', 'Most infrared radiation from astronomical objects which never reaches

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Helicopter Simulation Tests Control System

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to explore variations in Baseline system parameters. The second was to explore alternative mechanization concepts. Varying control gains not only provided data to be used in the control system design for the Ft. Rucker flight test, but also data for future design research. Various configurations of the helicopter, both with and without a slung load and with different control gains, were investigated. Each of the pilots flew various configurations to perform the following:

• Precision Hover
• Normal Departure (acceleration/deceleration)
• ILS (Instrument Landing System) Approach
• Missed Approach
• Speed Control

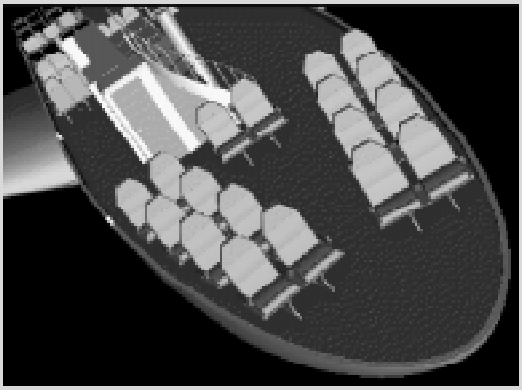
Six pilots "flew 1159 data runs, which included a variety of low altitude, low speed aggressive maneuvering flight tasks."

Each pilot flew several runs to familiarize themselves with the configurations and cues. This was followed by flying three to four runs for data collection. The pilots then evaluated the configurations by assigning handling qualities ratings and answering a questionnaire. A total of eight flight control system variations were flown. Six pilots, three from the US Army and one each from the US Navy, Boeing, and SYRE flew 1159 data runs, which included a variety of low altitude, low speed aggressive maneuvering flight tasks. The simulation was concluded successfully, and the researcher's requirements were met. The simulation was concluded successfully, and the researcher's requirements were met.

the ground is detectable from the lower stratosphere. This fact is the principal justification for an airborne telescope." At ground level, water vapor, carbon dioxide, and ozone interfere with infrared observations from even the largest and highest telescopes.

Although infrared astronomical research is SOFIA's main mission, as a flying observatory SOFIA will also allow astronomers to observe occultations and eclipses from anywhere in the world.

The Kuiper Airborne Observatory (KAO) flew as a NASA research aircraft for 21 years. Its replacement, SOFIA, is being developed and will operate as a joint project of the American and German space agencies, NASA and DLR. The SOFIA will have a ten times higher sensitivity and a three times better angular resolution than the KAO, due to the 2.5 meter (8-foot) German-engineered and crafted mirror and telescope assembly.



Passenger cabin as it might appear in SOFIA. It will be equipped with interphone headset and public address equipment and video projectors for announcements, audiovisual presentations, briefings and simple demonstrations.

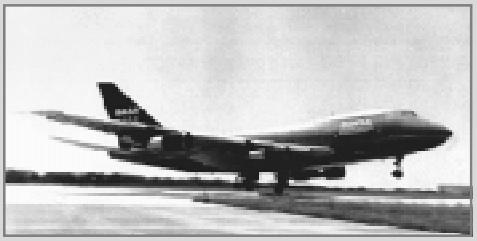
Last December the Universities Space Research Association (USRA) was awarded the $480 million contract to develop and operate SOFIA for NASA. The contract is managed by the SOFIA project office here at NASA Ames Research Center (ARC) and the observatory will be based at the Moffett airfield once the SOFIA is operational. Hanger 211 will be the SOFIA Science and Mission Operations Center.

According to the SOFIA web site, 'Starting in 2001 SOFIA will operate for a 20 year lifetime, conducting approximately 160 astronomy missions per year - about 7 hours each - for about 50 science teams, selected by annual peer review.' SOFIA will typically carry ten scientists and observatory staff, plus up to 10 visitors.

Research onboard the KAO led to over 50 Ph.D. theses for students at U.S. and foreign universities. Kindergarten through high school educators also participated in KAO missions. SOFIA will continue this excellent tradition of scientific, technical, and educational outreach around the world.

On April 11th of this year, NASA ARC hosted a dedication ceremony for the SOFIA 747, held at the San Francisco Airport. Several hundred attendees, including school children, NASA scientists, and representatives from the German space agency, participated. The ceremony included interactive displays and a keynote speech by Nobel prize-winning physicist (and experienced KAO observer) Dr. Charles H. Townes (U.C. Berkeley.)

In May, 1997, the SOFIA aircraft flew to the Raytheon-E Systems facility in Waco, Texas, where it will undergo extensive modifications over the next four years. Some of those modifications will be based on the SOFIA wind tunnel tests at NASA Ames Research Center.



The SOFIA 747 arrives at Waco, Texas.

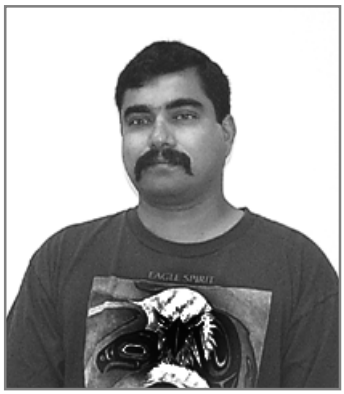
Employee of the Month Awards

Gene Devargas Supports Tram Test

Gene Devargas

The Civil Service Employee of the Month Award (September) was given to Gene Devargas, for his outstanding support of the TRAM test. As part of the final preparation for the test, the nacelle fairings had to be finished and painted. The model shop was not able to accommodate this last minute job, so Gene took it upon himself to prime and paint the fairings after hours to avoid any test delays. The finish on the fairings was outstanding! The following week, a second problem surfaced when it was discovered that the spinner fairing did not fit over the hub. It seemed that the only solution was to have Microcraft machine a new mould and have a new fiberglass part made, an extremely time consuming and expensive task. Once again, Gene saved the day. He willingly took on the task of fixing the existing fairing, adding a filler to the spinner, making a special jig, creating a plug from the shaped filler, and using the plug to make a new mould. He then fabricated a new fiberglass spinner from the mould he had just made, and finished and painted it. The new spinner looks great, and fit perfectly. Gene's initiative, skill, and great attitude were incredibly valuable to the TRAM test, and were critical to its success.

Bosco Dias Makes Innovative Simlab Recommendations



Bosco Dias

Bosco Dias (SYRE) has been named a Contractor Employee of the Month for September. Bosco is involved in the Alpha Development Facility Upgrade Project, which is to develop and integrate a next generation development environment at the VMS. Bosco came up with some unique ideas to maximize the capability of the environment through a very creative use of existing systems. He identified a number of deficiencies in Simlab's development capability, showed creativity and innovation in developing a strategy to correct the deficiencies, developed "Cheaper, Better, Faster" solutions, and consolidated the number and functions of several older VAX computers. Then going one step further, he re-examined the state of our main host systems and made recommendations to get the most from them as well. Bosco planned a new lab floor plan to improve overall efficiency of the computing resources. Finally, Bosco put together a solid presentation and shared his proposal with SimLab management. Suffice it to say, all recommendations were approved and we look forward to an increase in performance and usefulness of all our systems. Bosco's recent work has demonstrated once again that he is a key contributor at the VMS. Several SimLab staff members were sufficiently impressed with Bosco's innovative thinking and thoroughness that they spontaneously wrote notes of commendation to NASA and SYRE management pointing out the his accomplishments.

Jerry Guzman's Database Solution Saves $6000

Jerry Guzman

On behalf of AO, Jerry Guzman (CALSPAN) discussed the CMMS (Computerized Maintenance Management System) Maximo database Release 3.0A unreliability problems with Maximo supplier's (PSDI) customer support. The PSDI recommendation was to have a consultant come to Ames, at considerable expense, to correct the corrupted database. Another solution was developed during a joint AOF/Calspan/JFP/Bamsi meeting. This solution was for the system to be stepped back to a previous version, then reformatted to the correct conversion format, and then re-upgraded to the 3.0A version. The drawback to this solution was that reformatting would be time-consuming. Still, it was agreed by all that this solution was more prudent, and certainly much less expensive, than the alternative of having the PSDI consultant come to Ames.

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AO CONNECTIONS
(aocentral.arc.nasa.gov/ WhatsNew/Whats_new.html)

Editor:
Sharon Marcacci x4-5193
smarcacci@mail.arc.nasa.gov